Experiments on Teleoperation of Ground Robots using Motion Primitives

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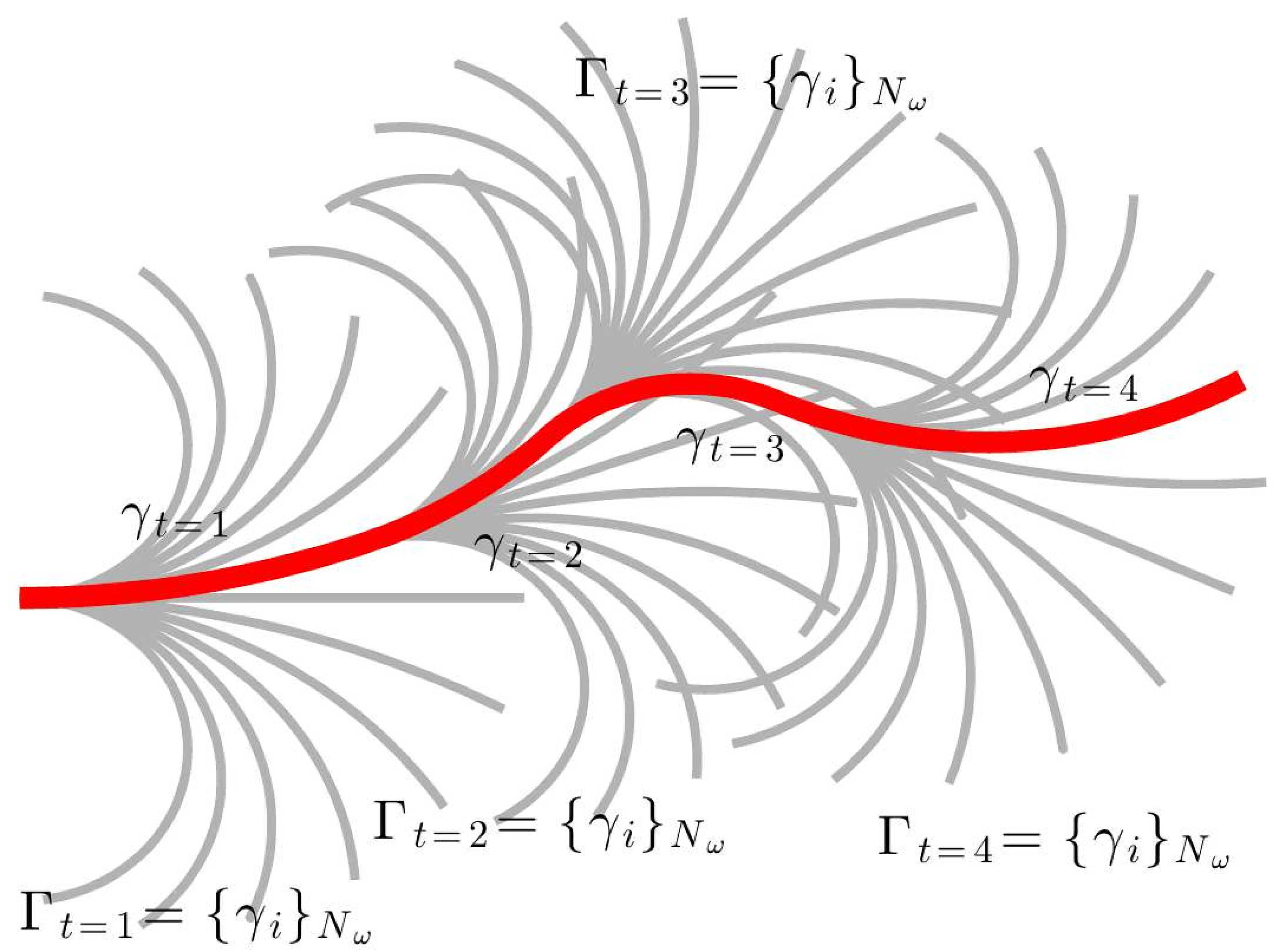
Research Objective

In this work, we develop a motion primitives based teleoperation approach for ground robots to enable safe and fast teleoperation.

In [1], authors present results assuming a perfect state estimate for a quadrotor vehicle. **This work pursues field results and performance evaluation given laser based state estimation.**

Approach



Forward Arc Motion Primitives

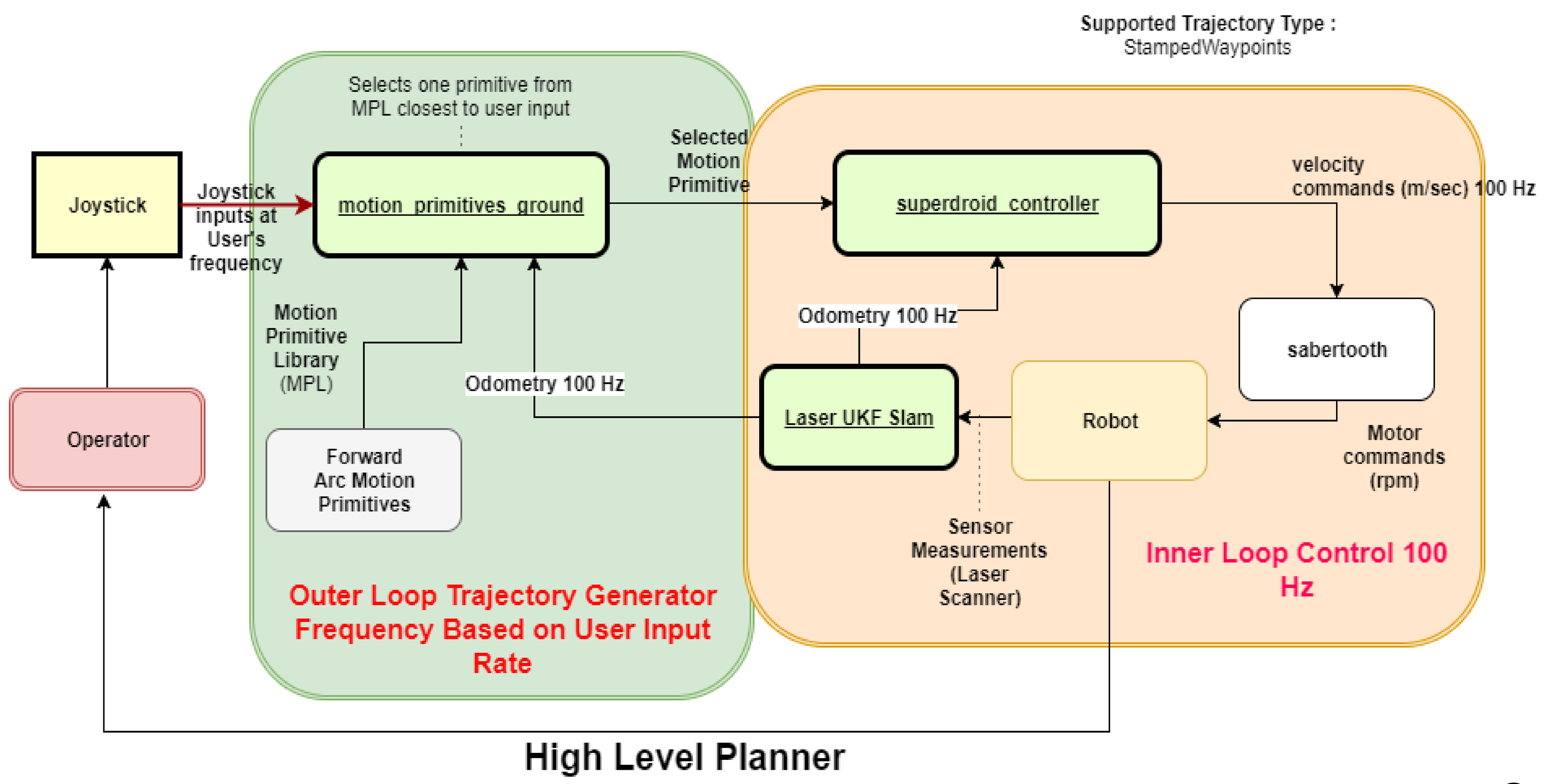
- Trajectories marked grey are dynamically feasible trajectories available to the user to follow based on the joystick input.
- Red trajectory is the one selected by the user.

Predicting User's Intent and Adapting Primitives.

- User's intent is predicted using Locally Weighted Projection Regression (LWPR) [1].
- Primitives shown in grey are adapted with respect to a belief distribution obtained from user's intent model.

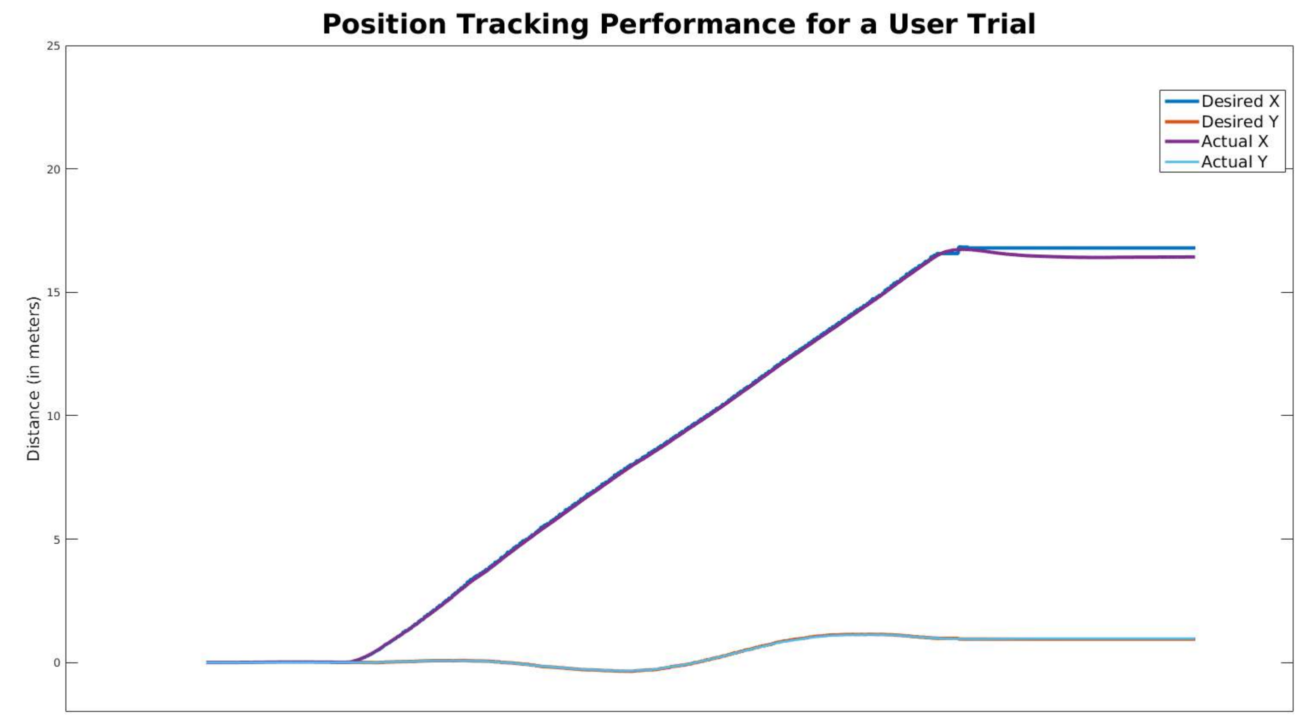
Methodology

- User acts as a high level planner and tries to follow a trajectory as shown in the experimental setup below.
- One primitive is selected out of the motion primitive library and is passed to the trajectory tracking controller.
- Proportional Derivative error based controller tracks the trajectory.

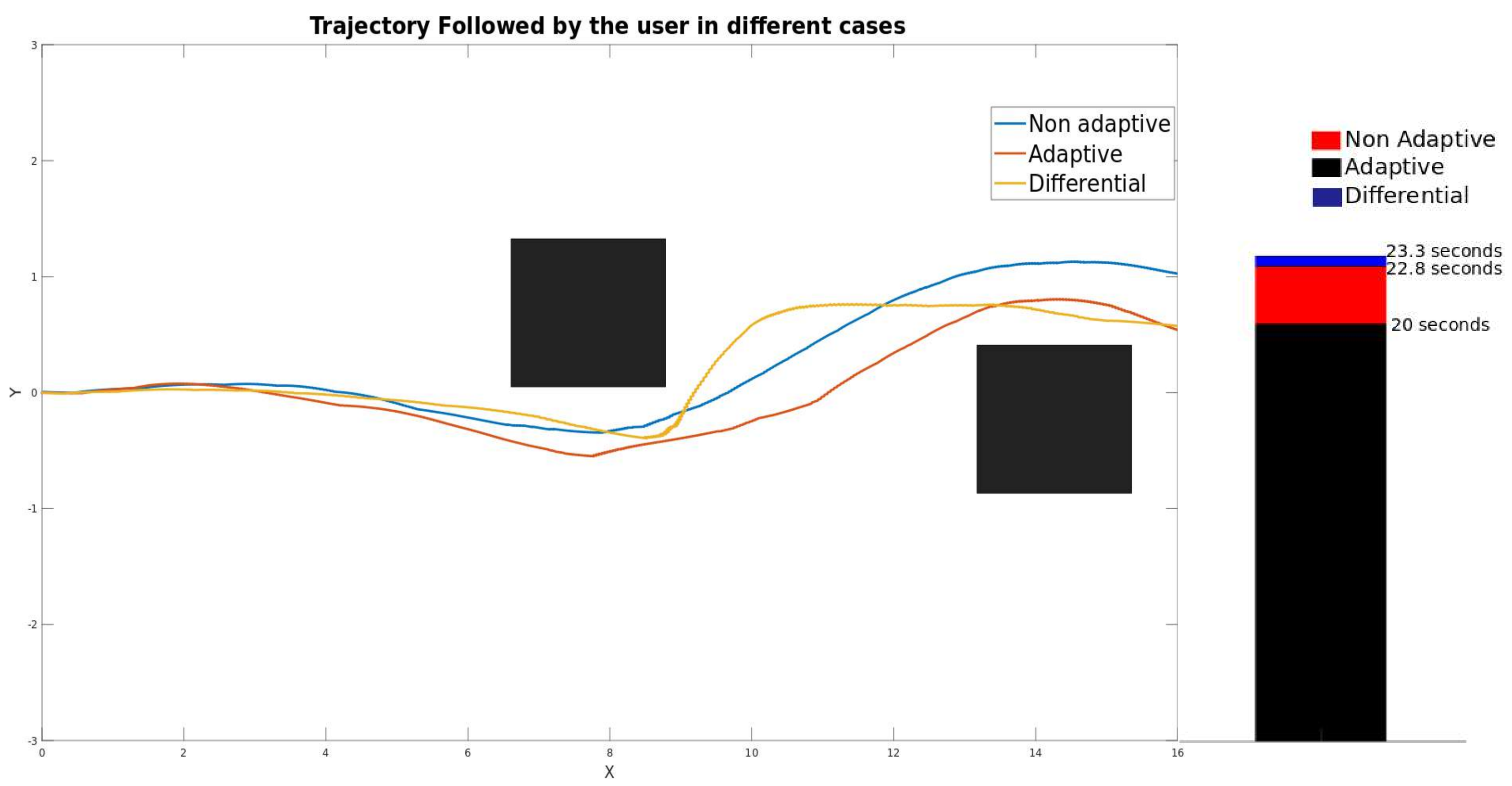


Preliminary Teleoperation Experimental Results

Test environment used for ground robot teleoperation tests*. The user navigates the robot around the black obstacles. The white line on the ground is provided as a reference.*



Position tracking control performance for one trajectory.



Comparison of three teleoperation strategies corresponding to a particular user trial in the ground test environment.

Conclusion

- Adaptive Teleoperation strategy shows promising results in terms of time taken to complete the trajectory.
- The trajectories followed in the case of assisted teleoperation are smoother than in the case of simple differential drive teleoperation.

Future Work

- Extend the adaptive teleoperation approach to enable tracking more agile and aggressive trajectories.
- Extend approach to consider aerial robots and multi-agent systems.

References

1. Xuning Yang, Koushil Sreenath and Nathan Michael, "A Framework for Efficient Teleoperation via Online Adaptation" *International Conference on Robotics and Automation (ICRA)*, 2017